

Claims

- 1 1. An air manager system for a metal air cell
2 comprising:
3 (a) a housing having an air mover and an air outlet
4 opening;
5 (b) a cartridge that is removable from said housing,
6 said cartridge having first and second ends, first and
7 second sides, and
8 (i) a metal air cell;
9 (ii) an air inlet opening located toward said
10 first end of said cartridge and adjacent to said first side
11 of said cartridge;
12 (iii) an air outlet opening located toward said
13 second end of said cartridge and adjacent to said second
14 side of said cartridge;
15 (iv) a first diffusion tube communicating with
16 said air inlet opening of said cartridge, said first
17 diffusion tube extending along said first side of said
18 cartridge;
19 (v) a second diffusion tube communicating with
20 said air outlet opening of said cartridge, said second
21 diffusion tube extending along said second side of said
22 cartridge;
23 (vi) a first distributor tube communicating
24 with said first diffusion tube, said first distributor tube
25 extending from said first diffusion tube along said first
26 side of said cartridge through a change of direction and
27 being adjacent to an air plenum, said first distributor tube
28 including a plurality of openings communicating with said
29 air plenum; and
30 (vii) a second distributor tube communicating
31 with said second diffusion tube, said second distributor
32 tube extending from said second diffusion tube along said

33 second side of said cartridge through a change of direction
34 and being adjacent to said air plenum, said second
35 distributor tube including a plurality of openings
36 communicating with said air plenum.

1 2. The air manager system of claim 1, wherein said
2 cartridge further comprises

3 (a) a first panel defining said openings of said
4 first distributor tube, wherein said first panel includes a
5 ridge, and wherein said first panel and said ridge form two
6 walls of said first diffusion tube and two walls of said
7 first distributor tube; and

8 (b) a second panel defining said openings of said
9 second distributor tube, wherein said second panel includes
10 a ridge, and wherein said second panel and said ridge form
11 two walls of said second diffusion tube and two walls of
12 said second distributor tube.

1 3. The air manager system of claim 1, wherein said
2 diffusion tubes, said distributor tubes, and said openings
3 cooperate to define a plurality of air flow paths through
4 said cartridge, all of said paths being substantially equal
5 in length.

1 4. The air manager system of claim 1, wherein said
2 air mover in said housing moves air into said air inlet
3 opening of said cartridge.

1 5. The air manager system of claim 4, wherein said
2 air mover is a blower.

1 6. The air manager system of claim 1, wherein said
2 air mover in said housing extracts air from said air outlet
3 opening of said cartridge.

1 7. The air manager system of claim 1, wherein said
2 diffusion tubes are sized to permit an air flow rate
3 therethrough of less than about 3.46×10^{-2} L/hour when said
4 air mover is off.

1 8. The air manager system of claim 7, wherein said
2 diffusion tubes are sized to permit an air flow rate
3 therethrough of less than about 3.46×10^{-3} L/hour when said
4 air mover is off.

1 9. The air manager system of claim 1, wherein each
2 of said diffusion tubes has a cross-sectional area of about
3 1 mm^2 to about 8 mm^2 and a length of about 10 mm to about
4 70 mm.

1 10. The air manager system of claim 1, wherein said
2 cartridge comprises a plurality of metal air cells.

1 11. The air manager system of claim 10, wherein
2 said cells are positioned in stacks, and wherein each stack
3 includes 2 cells that are spaced apart vertically to define
4 an air flow path therebetween.

1 12. The air manager system of claim 11, wherein
2 said cartridge comprises two stacks of cells, wherein said
3 stacks are spaced apart horizontally.

1 13. The air manager system of claim 10, wherein
2 said cells cooperate to define a battery that delivers a
3 current of at least 300 mA when said air mover is on.

1 14. The air manager system of claim 13, wherein
2 said cells cooperate to define a battery that delivers a
3 current of at least 500 mA when said air mover is on.

1 15. The air manager system of claim 14, wherein
2 said cells cooperate to define a battery that delivers a
3 current of at least 1000 mA when said air mover is on.

1 16. The air manager system of claim 15, wherein
2 said cells cooperate to define a battery that delivers an
3 average current of about 1700 mA when said air mover is on.

1 17. The air manager system of claim 13, wherein
2 said battery has an output current density of about 1 to 200
3 mA/cm² of air cathode surface when said air mover is on.

1 18. The air manager system of claim 17, wherein
2 said battery has an output current density of about 10 to
3 110 mA/cm² of air cathode surface when said air mover is on.

1 19. The air manager system of claim 1, wherein said
2 air mover generates an air flow rate through said cartridge
3 of about 0.04 to 40 L/hour.

1 20. The air manager system of claim 19, wherein
2 said air mover generates an air flow rate through said
3 cartridge of about 4 to 40 L/hour.

1 21. The air manager system of claim 1, wherein said
2 housing and said cartridge are configured such that when
3 said cartridge is placed in said housing, said air outlet
4 opening in said housing and said air inlet opening in said
5 cartridge are substantially aligned.

1 22. The air manager system of claim 21, wherein
2 said housing further comprises a cartridge release element
3 that allows air to exit said housing.

1 23. The air manager system of claim 22, wherein
2 said cartridge further comprises a locking tab that is
3 configured to interlock with said cartridge release element.

1 24. An air manager system for a metal air cell
2 comprising:
3 (a) a housing having an air mover and an air outlet
4 opening;
5 (b) a cartridge that is removable from said housing,
6 said cartridge having
7 (i) a metal air cell;
8 (ii) an air inlet opening;
9 (iii) an air outlet opening;
10 (iv) a first diffusion tube in communication
11 with said air inlet opening and a second diffusion tube in
12 communication with said air outlet opening;
13 (v) a first distributor tube in communication
14 with said first diffusion tube and a second distributor tube
15 in communication with said second diffusion tube; and
16 (vi) a first panel defining a plurality of
17 openings communicating with said first distributor tube and
18 a second panel defining a plurality of openings
19 communicating with said second distributor tube,

20 wherein said diffusion tubes, said distributor
21 tubes, and said openings cooperate to define a plurality of
22 air flow paths from said air inlet opening of said
23 cartridge, through said cartridge, to said air outlet
24 opening of said cartridge, all of said paths being
25 substantially equal in length.

1 25. A method for controlling air flow in a metal
2 air battery comprising:

3 (a) confining at least one metal air cell within a
4 cartridge, said cartridge having an air inlet opening and an
5 air outlet opening; and

6 (b) moving air through any of a plurality of air
7 flow paths within said cartridge,

8 wherein each of said paths passes through said air
9 inlet opening of said cartridge, through a diffusion tube,
10 through a distributor tube, across an active surface of a
11 cell, and through said air outlet opening of said cartridge,

12 and wherein all of said paths are substantially
13 equal in length.

1 26. The method of claim 25, wherein each of said
2 air flow paths passes through two diffusion tubes and two
3 distributor tubes.

1 27. The method of claim 25, wherein each of said
2 air flow paths passes through an opening in a panel.

1 28. The method of claim 25, wherein air is moved
2 through said cartridge by an air mover exterior to said
3 cartridge.

1 29. The method of claim 28, wherein said air mover
2 pushes air into said cartridge.

1 30. The method of claim 29, wherein said air mover
2 extracts air from said cartridge.

1 31. The method of claim 25, wherein step (b)
2 includes moving air through a diffusion tube, changing the
3 direction of air flow 180°, then moving air through a
4 distributor tube.

1 32. The method of claim 31, wherein step (b)
2 includes moving air through a diffusion tube, changing the
3 direction of air flow 180°, moving air through a distributor
4 tube, changing the direction of air flow 90°, then moving
5 air across an active surface of a metal-air cell.